

CLAIMS

What is claimed is:

1. A method for forming shallow trench isolation (STI) structure comprising the steps of:

providing a substrate comprising an overlying hardmask layer;

patterning the hardmask layer to form a hardmask layer opening for etching a trench through a substrate thickness portion;

etching a trench according to the patterned overlying hardmask layer;

carrying out a wet chemical oxidizing process to form an oxidized surface portion on the hardmask layer;

carrying out a wet chemical etching process to remove at least a portion of the oxidized surface portion to form the hardmask opening having an enlarged width and the trench opening comprising rounded upper corners; and,

forming a completed planarized STI structure filled with oxide.

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2. The method of claim 1, where in the substrate is selected from the group consisting of silicon, silicon germanium, and gallium arsenide.
3. The method of claim 1, wherein the hardmask layer comprises silicon nitride.
4. The method of claim 1, wherein the step of carrying out a wet chemical oxidizing process comprises contacting the hardmask layer with an oxidizing solution.
5. The method of claim 4, wherein the oxidizing solution comprises hydrogen peroxide (H_2O_2) and sulfuric acid (H_2SO_4).
6. The method of claim 5 wherein the oxidizing solution comprises a volumetric ratio of hydrogen peroxide (H_2O_2) to sulfuric acid (H_2SO_4) of about 2 to 1 to about 10 to 1.
7. The method of claim 1, wherein the temperature of the oxidizing solution is from about 100 °C to about 150 °C.

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8. The method of claim 1, wherein the oxidized surface portion comprises a thickness of about 50 Angstroms to about 300 Angstroms.

9. The method of claim 1, wherein the step of carrying out a wet chemical etching process comprises contacting the oxidized surface portion with HF.

10. The method of claim 9, wherein the HF comprises an HF containing solution.

11. The method of claim 10, wherein the HF containing solution comprises HF diluted with deionized water.

12. The method of claim 1, wherein the at least a portion of the oxidized surface portion has a thickness of from about 50 Angstroms to about 300 Angstroms.

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13. The method of claim 1, wherein the step of forming a completed planarized STI structure comprises the steps of:

forming a liner comprising at least one layer selected from the group consisting of silicon oxide, silicon nitride, and silicon oxynitride;

backfilling the trench with at least one layer of STI oxide selected from the group consisting of HDP-CVD silicon oxide, CVD silicon oxide, and SOG silicon oxide;

removing the excess STI oxide above the hardmask layer according to a planarization process; and,

removing the hardmask layer according to a wet chemical etching process.

14. A method for forming shallow trench isolation (STI) structure to form rounded trench upper corners comprising the steps of:

providing a substrate comprising an overlying silicon nitride hardmask layer;

patterning the hardmask layer to form a hardmask layer opening for etching a trench through a substrate thickness portion;

etching a trench through a substrate thickness portion

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according to the patterned overlying hardmask layer;

carrying out a wet chemical oxidizing process comprising sulfuric acid and H_2O_2 to form an oxidized surface portion on the hardmask layer;

carrying out a wet chemical etching process comprising HF to remove at least a portion of the oxidized surface portion to form the hardmask opening having an enlarged width and the trench opening comprising rounded upper corner portions; and,

forming a completed planarized STI structure filled with oxide.

15. The method of claim 14, where in the substrate is selected from the group consisting of silicon, silicon germanium, and gallium arsenide.

16. The method of claim 14, wherein the hardmask layer further comprises an uppermost layer of silicon oxynitride.

18. The method of claim 14 wherein the oxidizing solution comprises a volumetric ratio of hydrogen peroxide (H_2O_2) to sulfuric acid (H_2SO_4) of about 2 to 1 to about 10 to 1.

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19. The method of claim 14, wherein the temperature of the oxidizing solution is from about 100 °C to about 150 °C.

20. The method of claim 14, wherein the oxidized surface portion comprises a thickness of about 50 Angstroms to about 300 Angstroms.

21. The method of claim 14, wherein the HF containing solution comprises HF diluted with deionized water.

22. The method of claim 14, wherein the at least a portion of the oxidized surface portion has a thickness of from about 50 Angstroms to about 300 Angstroms.

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23. The method of claim 14, wherein the step of forming a completed planarized STI structure comprises the steps of:

forming a liner comprising at least one layer selected from the group consisting of silicon oxide, silicon nitride, and silicon oxynitride;

backfilling the trench with at least one layer of STI oxide selected from the group consisting of HDP-CVD silicon oxide, CVD silicon oxide, and SOG silicon oxide;

removing the excess STI oxide above the hardmask layer according to a planarization process; and,

removing the hardmask layer according to a wet chemical etching process.